ETN NEWS

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ETN is a non-profit association bringing together the entire value chain of the gas turbine technology community globally. Through cooperative efforts and by initiating common activities and projects, ETN optimises turbomachinery research and technology development and promotes the operation of environmentally sound gas turbine technology with high reliability and low cost.

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Christer Björkqvist Managing Director

Entering a new era! The "Green deal" and "Hydrogen Gas Turbines"

The European Commission's new president, Ursula von der Leyen, announced in December the EU's "Green Deal" roadmap towards the political ambition to become the first carbon-neutral continent by 2050. It surely does not lack ambitions as it covers everything from transport, energy, buildings, agriculture and industries such as steel, cement, ICT, textiles and chemicals, as well as how the EU will spread its vision beyond its borders to the wider world. Some criticism has already arisen from several sources for lacking a detailed plan behind the vision. According to me it includes all the necessary elements for a great vision; an ambitious mission, a purpose with parameters for

success and a deadline. The first step is to build up a wave of ideas and solutions to achieve this vision in a cost-efficient way. When everyone starts looking in the same direction that's when things start happening. It is up to us as an industry as a next step to highlight how we can contribute to the realisation of this vision which enables a development and implementation of a more concrete plan. That's why I am very pleased by the recent timely release of the "Hydrogen Gas Turbines" report produced by ETN's Hydrogen Working Group. This report describes the path towards a zero-carbon gas turbine and the important role these developments will have to enable a cost-efficient decarbonisation process in both the energy transition and in a carbon-neutral society.

The momentum for hydrogen increased quite dramatically in 2019 not only in Europe but also in other parts of the world with Japan parallel to the EU in the lead. During my visit to Japan in November it was demonstrated that hydrogen solutions are seen in Japan as a great opportunity with a key role in their future energy roadmap. In late November last year the government of Australia also released its "National Hydrogen Strategy" which highlights that hydrogen is set to become a key domestic source of energy with export opportunities. This was confirmed by a recently signed cooperation agreement between Japan and Australia on production and export of hydrogen to Japan.

Within ETN we are both trying to widen and surf the hydrogen wave by bringing together all the relevant stakeholders and experts needed to kick-start a Hydrogen economy. ETN's Hydrogen report highlights advantages of hydrogen gas turbines, the state of the art of hydrogen combustion, technical challenges and research needs as well as the importance of developing and demonstrating retrofit solutions for the current fleet of gas turbines. In short a roadmap of how gas turbines together with hydrogen as future energy vector can enable a smooth transition towards a carbon-neutral society.

Not only fuel flexibility is being addressed on the ETN platform but also other important and connected topics such as efficiency improvements, additive manufacturing, life assessment, air filtration, and promising advanced future cycles like supercritical CO_2 . In 2020 we have many interesting meetings planned and I would in particular like to bring to your attention our 10th International Gas Turbine Conference (IGTC) "Gas Turbines in carbon-neutral society" that will take place 14-15 October in Brussels, Belgium.

I look forward to an active involvement in 2020 in our IGTC, Working Groups, Projects, Workshops and User meetings. You will find more information of the planned activities in this newsletter and on our website. Finally, don't forget to register for our Annual

General Meeting & Workshop 18-19 March in Amsterdam, generously hosted by Shell, which will be a meeting not to be missed.



ETN Hydrogen Gas Turbines report – The path towards a zero-carbon gas turbine

ETN's Hvdrogen Working Group published a new report "ETN Hydrogen Gas Turbines – The path towards a zero-carbon gas turbine". This report highlights the advantages of hydrogen gas turbines, involving the contributors across the whole value chain. The report assesses the pre-conditions of a hydrogen power plant. describes the current stateof-the-art of hydrogen combustion and analyses what is needed for the retrofit of existing gas turbines. The report also gives an overview of the current capabilities of gas turbines burning hydrogen, providing information on the OEMs' new equipment and retrofits.

Gas turbines already fulfil the crucial balancing role in the energy system. By extending the fuel capabilities of gas turbines to hydrogen, their role can become predominant in the energy transition period but also in long-term energy strategies:

- In combined cycle configuration (CCGT), gas turbines are already the cleanest form of thermal power generation. For the same amount of electricity generated, gas turbines running on natural gas emit 50% less CO₂ emissions than coal-fired power plants (1)
- Mixing renewable gas (e.g. green hydrogen, biogas, syngas) with natural gas enables further reduction in CO₂ emissions. This can be achieved by direct injection in gas grids or at plant level (2)



The role of gas turbines in the global energy transition

- Industry is committed to enable gas turbines to run entirely on renewable gas fuels by 2030 and therefore achieve capabilities for 100% carbon neutral gas-fired power generation. The ensuing objective being to implement power plants reaching 65%+ thermal efficiency in combined cycle configuration (3)
- Gas turbines are flexible, well-suited for frequent starts, and able to provide a fast response to grid demands, making them complementary to the variable RES.

In 2018 over a fifth of European electricity was produced by coal-fired power generation. At the same time Europe has a large existing fleet of relatively new, highly efficient and very flexible gas turbines, both in open and combined cycle configuration, that operate at a limited percentage of their total capacity.

By accelerating a shift from coal-fired to gas-fired power generation, Europe can take a massive step forward in decarbonising the sector during the next ten years with relatively limited efforts and investments and with a future-proof technology. Hydrogen gas turbines would, in essence, complement the intermittent nature of wind and solar power since they can be used as back-up power. Hydrogen can be produced via electrolysis, using excess renewable power during periods of abundant wind and daylight, or by natural gas reformation, which is also a carbon neutral resource if carbon capture technology is utilised. In this context hydrogen reforming can be seen as the kick-starter to create sufficient hydrogen supply on short notice and enable the creation of a hydrogen infrastructure, including storages. The scalability of gas turbines from small decentralised to large centralised systems allows for adaptation to the production capability and local storage. All in all, hydrogen gas turbines can be an enabler for long term energy storage with power-to-gas technologies. Read more about our analysis in our <u>report</u>.

We would like to thank especially our coordinator Peter Kutne (DLR) and the main contributors Mirko Bothien (Ansaldo Energia), Peter Breuhaus (NORCE), Peter Griebel (DLR), Burak Kaplan (MHPS), Geert Laagland (Vattenfall) and Peter Stuttaford (Ansaldo Thomassen), as well as the rest of the ETN Hydrogen Working Group.

The full report can be downloaded here: www.etn.global/hydrogen-report

ETN's Annual General Meeting and Workshop

This year's Annual General Meeting (AGM) and Workshop will take place on 18-19 March 2020 in Amsterdam, Netherlands, kindly hosted by our member Shell. Join us in Amsterdam to receive updates on ETN's ongoing activities, influence ETN's strategy, participate in our Technical Committee sessions and identify new projects and activities. It will be an excellent opportunity to welcome 11 new members who have joined the network since the last AGM in Pau and to meet with the rest of the network. This will be an important event as the new ETN Board for 2020-2022 will be elected at the Annual General Meeting.

Venue and agenda

ETN's AGM & Workshop will take place at Shell Technology Centre Amsterdam. The AGM programme will start on 18 March and consists of the annual report on ETN's activities and achievements, discussion on the proposed strategy, ETN Board election and discussions on research and innovation strategies and future opportunities. The second day will be dedicated to ETN's Workshop and parallel Technical Committee sessions, covering topics such as next generation power cycles, gas turbine operational and fuel flexibility, additive manufacturing and new materials, as well as condition monitoring and asset management. Preliminary programme for the event is available on <u>ETN's website</u>.

Registration

It is possible to register to the event via this link. The event is open only to ETN members and invited guest speakers.

Accommodation

ETN has negotiated special rates for rooms at Room Mate Aitana hotel. We have some rooms available for ETN members also at NH Amsterdam Noord and Park Plaza Victoria Amsterdam hotels. You can find more details on ETN's website.

Transport

Shell Technology Centre Amsterdam is located on the north side of Amsterdam, and can be easily accessed by a free ferry from Amsterdam central railway station where international and airport trains stop.

IGTC-2020: call for exhibitors

ETN's International Gas Turbine Conference "Gas turbines in a carbon-neutral society" will take place on 14-15 October 2020 at Le Plaza Hotel in Brussels, Belgium. The conference will provide an exclusive opportunity for your organisa-

tion to show your potential contributions in the energy transition to a carbonneutral society. The IGTC-20 Conference Advisory Board invites companies to present technical research, developments and solutions in line with the <u>Call for Papers</u> topics.

We still have a few <u>exhibition spots</u> available – if you would be interested to showcase your technology developments, products and services, please <u>get in touch</u>!

New member

We warmly welcome Gas Technology Institute who recently joined ETN.

gti.

Gas Technology Institute (GTI) is an applied R&D organisation that has been addressing global energy challenges by developing technology solutions for consumers, industry, and government for more than 75 years. GTI applies energy and aerospace experience to lower energy costs and provide cleaner sources of fuel and power with technology-based solutions, including technologies related to natural gas and hydrogen production and conversion, and supercritical CO₂ based power cycles.



Young Engineers Committee

The aim of this new ETN initiative is to provide promising engineers at the start of their career an opportunity to interact with leaders and technical experts of the ETN community and learn more about the energy industry. The role of the Young Engineers Committee will be to support and develop ideas and projects of common interest in the energy transition and to help ETN to progress towards our objectives. The initiative will be introduced to the General Assembly at the AGM & Workshop and it will be further discussed with ETN members during the event.

ETN AT WORK

ETN in Japan



ETN's Managing Director Christer Björkqvist attended the Gas Turbine Society of Japan's International Gas Turbine Congress that was held in Tokyo on 17-22 November 2019. Christer Björkqvist was one of the keynote speakers in the closing panel session "Turbine technology development in a low carbon society and a hydrogen society" presenting ETN's vision for development and implementation of carbon-neutral turbomachinery solutions and the European Commission's newly launched "Green Deal" as well as outcomes of ETN's past H_2 -IGCC project and ETN's Hydrogen Working Group.

Major OEMs like MHPS, Kawasaki HI, Siemens and GE all provided reports of their ongoing technology developments for a low-carbon society prior to panel discussion on challenges that we need to overcome in the transition. Hydrogen solutions are seen as a great opportunity in Japan and development and implementation of cost-efficient hydrogen-based energy systems have a high priority in their future energy roadmap. The importance of international cooperation and especially work on a common safety standard and exchange of experiences when it comes to demonstration projects were acknowledged as important cooperation activities going forward.

Parallel discussions and meetings were held with key Japanese stakeholders on how we could kick-start a hydrogen economy and collaboration opportunities in order to accelerate the development of flexible turbomachinery solutions that can operate on different fuel mixtures, not only for newly built but also retrofit solutions for the current fleet.

Christer Björkqvist and Peter Jansohn, Chair of ETN Project Board (PSI) were also kindly invited to MHPS' research and innovation centre and workshop in Takasago. It was a very interesting visit that showcased the commitment by MHPS to both further increase the efficiency and fuel flexibility to renewable fuels.

ASME Advanced Manufacturing & Repair for Gas Turbines



ASME Advanced Manufacturing & Repair for Gas Turbines (AMRGT) <u>conference</u> will take place on 3-4 March 2020 in Charlotte, North

Carolina, US. ASME AMRGT is dedicated solely to advanced manufacturing for gas turbines. This user-focused conference will share best practices and new technologies implemented on successfully advanced manufacturing techniques to improve efficiencies and reduce maintenance costs within operations. Join the event to learn, share and build relationships with the full supply chain of companies involved with advanced manufacturing for gas turbines. ETN members are entitled to a discounted registration fee for this event; please contact us for more details.

ETN User Group meetings

ETN's LM2500 User Group meeting will take place on 2-4 June 2020 in Aberdeen, UK, with the support of BP. More information about the event is available on <u>ETN's website</u>.

The SGT-A35 User Group meeting will be held in early May 2020 – more details will follow soon. ■



ETN AT WORK

ETN standard on exhaust systems to be published as an ISO standard

ETN's Working Group on Exhaust Systems dates back to 2009 when the project was initiated by a few members of ETN's user community who experienced problems with their exhaust systems. The objective of this project was to bring together operators facing similar problems with their exhaust systems, as well as exhaust system designers and external expertise and support, who could address the problems by developing a common standard for the design of gas turbine exhaust systems. In the first phase of the project, the group carried out a gap analysis, uploaded an index to facilitate the creation of the standard, and collected valuable material. During various meetings the group decided to focus its activities on the creation of the Waste Heat Recovery Unit (WHRU)

standard and later amend the existing API standard on Heat Recovery Steam Generators (HRSG).

It was decided that the standard should highlight the possibilities and importance of computational fluid dynamics (CFD) simulation. The group agreed that the best way to validate the CFD code was to use a benchmark case which could be included in the appendix of the standard. The core group wrote the Description of Work for the benchmark test, explaining the benefits of the study and including a clear timeline and financial overview.

The ETN standard was issued in 2015, and in February 2016 the ISO/TC 192 initiated a New Work Item aiming at drafting an ISO standard on the WHRU.

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ETN Standard – Gas Turbine Exhaust Systems with or without waste heat recovery equipment for ol & gas, chemical and process industries	

In October 2019 the final draft of the "ISO21905 - Gas turbine applications

- Requirements for exhaust and heat recovery unit" was submitted for formal approval to the ISO/TC 192 WG 16. The document is now in its final approval process, with all review phases being passed, and publication of the standard is scheduled for mid-2020. The ETN standard and other Exhaust Systems WG documents are available for ETN members on <u>our website</u>.

Additive Manufacturing Equipment Database

During the last months ETN's Additive Manufacturing (AM) Working Group has been working on a new equipment database. The ETN Additive Manufacturing Equipment Database will provide an overview of available AM equipment on the market. Once the platform is launched the ETN members will be invited to collaborate and share information with the community. Additional AM Suppliers Database will also be created at a later stage. The AM Equipment Database will be online in February – stay tuned!

ETN initiative for EU Innovation Fund

EU's Innovation Fund is one of the world's largest funding programmes for demonstration of innovative low-carbon technology. The EU Emissions Trading System is providing the revenues for the Innovation Fund from the auctioning of 450 million allowances from 2020 to 2030, as well as any unspent funds from the EU's NER300 programme. The Innovation Fund will focus on highly innovative technologies and big flagship projects with European added value that can bring on significant emission reductions.

ETN aims to identify key topics of interest within our network that could meet the objectives and requirements of the Innovation Fund and is currently gathering input from ETN members with the objective to submit a proposal to the European Commission.

The first topic discussed during ETN's Project Board meeting in December was the retrofit of operating gas turbines with the aim to burn an increased share of hydrogen. ETN organised the first teleconference with the ETN members earlier in January and is now following up with the interested parties to write a proposal. If you would be interested to join this initiative, please <u>contact us</u>.

THE GT INDUSTRY



Interview with PUMP-HEAT consortium

We interviewed the consortium of the EU funded PUMP-HEAT project (Performance Untapped Modulation for Power and Heat via Energy Accumulation Technologies). The project started in 2017 and six ETN members (University of Genoa, RINA, KTH, Ansaldo Energia, MHPS and Siemens) are part of the consortium.



Could you give a short introduction to the project?

The PUMP-HEAT project is pioneering the hybridisation of gas turbines and combined cycles with heat pumps. In fact, at the state of the art, heat pumps without thermal energy storage (TES) have been proposed and implemented in some locations (mainly Middle East and North Africa) to avoid power reduction due to hot climates, and to cope with the high air conditioning power request during day time. However, the hybridisation of combined cycles (CC) with heat pumps (HP) has never been targeted as a flexibility enhancement option. This is the main scope of work of PUMP-HEAT partners, which is an industry-driven consortium.

What are the goals of this project?

The PUMPHEAT project aims at assessing the potential benefits in terms of additional flexibility, extended range of operation and improved profitability of various layouts where large-size heat pumps are integrated with gas turbine combined cycles. Two basic configurations are investigated: layouts for the power-oriented CC, where the plant is producing only electrical power, and layouts for the cogenerative CC, where the plant is producing both power and heat for local thermal users. Such layouts are also going to



be demonstrated experimentally: the power oriented layout will be validated at the University of Genoa laboratories, with a combined cycle emulator based on a T100 microturbine, while the cogenerative layout will be demonstrated at the IREN Moncalieri combined cycle in Turin. Further detailed experimental activities are on-going at KTH laboratories regarding advanced solutions for thermal energy storage based on phase change solutions.

In a word, PUMP-HEAT is going to demonstrate that thermal storage plus heat pump can be integrated into CCs as an equivalent electrical storage, providing similar technical flexibility at much more affordable cost effectiveness.

What are the key results so far?

The project has recently overcome the 24 months activity, and already counts on robust scientific bases towards technological demonstration. Key exploitable results addressing energy system integration encompass the PUMP-HEAT combined cycle layouts, electrical marcontinued on page 7

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ETN GLOBAL

Interview with PUMP-HEAT consortium

continued from page 6

ket targeted predictive control system for fast-response heat pumps, data driven physics based dynamic simulation environment, phase-change materials and designs for large size thermal energy storage, innovative bladeless expander for energy harvesting in ultraefficient heat pumps. At the same time, demonstration of the PUMPHEAT integrated solution in a real CC is showing that barriers exist, but mainly related to safety and authorisation, which may require time for large-scale deployment.

What do you hope to be the impact of the project?

Every CC plant will have to work on flexibility in next years, to access the capacity markets, which are being developed in more and more countries in EU but also increasingly across the globe. Considering that PUMPHEAT solution can be applied both to existing plants and to new ones, its wide impact is really promising. It is estimated that the PUMPHEAT solutions will enable, for both new and existing CCs: an >3% annual reduction of OPEX; an efficiency enhancement of up to 15% in summer and up to 10% in winter for minimum load and part load; a reduction of the start-ups and heavy ramp-ups thanks to HP, TES and CC integration, allowing for a saving of up

Electrical Equivalent Thermal Storage					
Off-peak	HP Electricity Consumption	20	MWh el		
	HP EER (energy efficiency ratio)	3	_		
	Stored Energy @ 5°C	60	MWh c		
Shift in time					
Peak	TES Efficiency	90%	%		
	Released Energy @ 5°C	54	MWh c		
	Inlet Cooling requirement	18	MW c		
	Time for peak operation	3.0	h		
	CC Increased output (+14%)	45	MW		
	Additional Energy produced	135	MWh el		

Effect of PO on a 400 MW CC

to 40000 Sm³ of NG per start-up (for a 400 MW CC). By looking at the overall performance reported in the table, which refer to a 400MW CC for Power Oriented application, one can see that the "equivalent" storage in cooling of 20MWh during off-peak hours may result into an energy boost of 135MWh additional electrical energy available for the on-peak hours. Such numbers are demonstrating the superior flexibility attainable with the PUMP-HEAT concept versus conventional electrical storage.

Do you have any follow-up plans?

The next step is to find stakeholders worldwide interested in providing data for replication analysis. We are looking for utilities or energy companies

who would be interested in sharing data about the potential application of PUMP-HEAT solutions at their sites, either as retrofit application or as new plant. In this respect, the role of ETN is highly important as a forum to match the gas turbine OEMs' solutions and the gas turbine users' needs, and we thank you for your support.



Read more about the project here: www.pumpheat.eu

Users who would be interested to participate by sharing data can contact the <u>ETN office</u>.

Climate-neutral EU by 2050

In December 2019 the European Commission President Ursula von der Leyen presented the <u>European Green Deal</u>, the European Commission's package of policy initiatives needed for reaching the zero-carbon greenhouse gas objective in the EU by 2050. The Commission is presenting the "first European Climate Law" by March 2020 to include the 2050 climate neutrality objective in legislation.

The Commission proposes to increase the EU's 2030 carbon emission reductions target from the current 40% to at least 50%, and aiming for 55%, compared to the 1990 levels. This will require a review of "all relevant climaterelated policy instruments" by June 2021, including the current climate legislation, such as the EU's Emissions Trading System. The Commission also proposes a carbon border adjustment mechanism. for selected sectors. "to reduce the risk of carbon leakage". Other Green Deal initiatives include improvements in energy efficiency and buildings, energy taxation, circular economy and transport.

The importance of smart infrastructure is also highlighted, as increased crossborder and regional cooperation would help achieve the benefits of the clean energy transition at affordable prices. According to the Green Deal, this would also foster the "deployment of innovative technologies and infrastructure, such as smart grids, hydrogen networks or carbon capture, storage and utilisation, energy storage, also enabling sector integration".

On the same day as the European Commission introduced its Green Deal, the EU leaders met in Brussels at the European Council meeting to discuss the EU member states' commitment to become climate-neutral by 2050. At the meeting Czech Republic and Hungary joined the group backing the 2050 zero-emission target, but Poland still refused to commit to the common objective, saying that the country would need a guarantee on funding for making the switch from coal to cleaner energy sources.

The EU leaders will discuss the topic again in June 2020 under the Croatian

rotating presidency of the Council of the EU. Hopes are high that Poland will eventually be on board and the EU's position aligned before UN's next climate change conference COP26, to be held in Glasgow in November 2020.

The COP25, held in Madrid in December 2019, ended with <u>no significant outcomes</u>, as big decisions were again postponed until the next COP conference.

To finance the ambitious climate neutrality target, the European Commission recently announced its European Green Deal Investment Plan, consisting of \pounds 1 trillion in sustainable investments over the next decade. The plan includes also the "Just Transition Mechanism" that aims to support the regions and sectors that are most affected by the energy transition, with "at least \pounds 100 billion in investments over the period 2021-2027".

The budget for the Green Deal Investment Plan will be built up by contributions from the EU's long-term budget, member states and private actors, but the exact split is still under discussion.

SET Plan Action 6 event in Brussels

ETN co-organised the European Strategic Energy Technology (SET) Plan Action 6 Networking event, together with the Action 6 secretariat, on 4 December 2019 in Brussels. The aim of SET Plan Action 6 is to make EU industry less energy and resources intensive, more carbon-neutral and competitive. The event focused on cooperation and finance for improved energy efficiency in industry, and specifically in steel production, chemicals, heat and cold technologies and system integration.

ETN planned the programme and moderated the session "*Heat and Cold Living Lab*". Marco Ruggiero (Baker Hughes) and Olaf Bernstrauch (Siemens) co-presented *Waste Heat to Power sCO₂ cycles* and Maija Mäkinen (Aurelia Turbines) gave a presentation on *Polygeneration system for the small scale industry*. All presentations are available on ETN's website.



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Upcoming meetings and events

Meeting/Event	Date	Location
ETN Board meeting	12-13 February	Brussels, Belgium
ASME Advanced Manufacturing & Repair for Gas Turbines*	3-4 March 2020	Charlotte, North Carolina, US
ETN Project Board meeting	18 March 2020	Amsterdam, Netherlands
ETN Board meeting	18 March 2020	Amsterdam, Netherlands
ETN Annual General Meeting & Workshop**	18-19 March 2020	Amsterdam, Netherlands
$7^{\rm th}$ International Supercritical $\rm CO_2$ Power Cycles Symposium	30 March – 2 April 2020	San Antonio, Texas, US
ETN SGT-A35 User Group Meeting	May 2020	To be confirmed
NexTurbine*	27-29 May 2020	Suzhou, China
ETN LM2500 User Group Meeting	2-4 June 2020	Aberdeen, UK
ASME Turbo Expo*	22-26 June 2020	London, UK
ETN High-Level User Meeting	13 October 2020	Brussels, Belgium
ETN's 10 th International Gas Turbine Conference 2020	14-15 October 2020	Brussels, Belgium

* ETN members are entitled to a discounted registration fee | ** Event only for ETN members

ETN Team



Christer Björkqvist Managing Director



Noora Kilpinen Communications Officer



Ugo Simeoni Research & Innovation Manager -Policy and Projects



Valentin Moëns Technical Project Officer



Ilona Kolb Financial and Administrative Officer



External

Consultant

Alfonso Pandolfi Technical Project Assistant

ETN at a Glance!

Download the ETN Brochure and find out more about our mission & objectives, activities, events and more!



Are you interested to become an ETN member? Download the <u>one-pager</u> showcasing the benefits of being part of ETN's global turbomachinery community.





Keep in contact and updated with ETN's most recent news. Follow ETN on Twitter: @etngasturbine and on LinkedIn!



ETN a.i.s.b.l Chaussée de Charleroi 146-148/20 = 1060 Brussels = Belgium Tel: +32 (0)2 646 15 77 = <u>info@etn.global</u> = <u>www.etn.global</u>